



The Source

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Water Loss and Leak Detection

INTRODUCTION

Water loss is a problem for almost every water system. Sometimes it is easy and other times it is very difficult to find the source of the problem.

WHAT ARE THE BENEFITS OF FINDING LOST WATER?

- ◆ Reduced equipment wear.
- ◆ Lower electricity bills and other operating costs for treating, pumping, and storing water.
- ◆ Improved public relations with lower rates and improved service.
- ◆ Possible elimination of costly capital improvements; plus additional capital available to expand service.
- ◆ Protection of public health, e.g., reduced risk of cross-connections.
- ◆ Lower insurance costs and reduced liability.
- ◆ Conservation of a precious resource—with pollution and increasing demand, this is more important all the time.

WHAT ARE THE TYPES OF WATER LOSS?

Water loss is unmetered water that leaves a water system. In some cases, water only seems to be missing due to human error or other er-

rors such as broken meters. But genuine water loss is generally caused by three things: authorized unmetered accounts, theft, and leaks.

Authorized, unmetered accounts.

These are legal, but unmetered connections, often for special users at no charge. This practice is not recommended—meters should be installed for all users including those that are not billed.

Estimate the amount of water that has been used for the past year and use this figure to adjust estimates you have made for water your system is losing.

Unmetered accounts may include free accounts (elderly, low-income, special arrangements), city facilities (offices, water/wastewater plants, parks, golf courses, cemeteries, swimming pools, fountains), community facilities (offices, schools, churches, hospitals, rest homes), firefighting, special events (fairs, construction), and maintenance equipment and procedures (water line/hydrant flushing, sewer/street cleaning, storage tank drainage, pump/turbine cooling, filter backwashing).

Theft. Water loss here is due to unauthorized connections. These include disconnected sources illegally reconnected, closed accounts

that have been illegally reopened, illegal taps on distribution lines, connections to fire hydrants for non-emergency use, meters that have been turned around, meters with registers removed, and illegal taps that bypass meters.

Look for signs of theft when reading meters or performing any other work on the distribution system. Be familiar with the legal rights of water systems in your area and stop unauthorized use as soon as you discover it. Estimate the amount of loss due to unauthorized connections and adjust any estimates you may have made.

Leaks. A leak is any hole, crack, or flaw in the system that permits the uncontrolled flow of water. Leaks are the hardest form of water loss to control for most systems.

Examples: a hole in a pipe, an overflowing storage tank, worn pump packing or damaged fire hydrant seat, and a check valve that lets water drain back into a well. Underground leaks often go undetected for long periods. This is because *not all leaks surface!*

MAPS

A leak detection survey is the first step in finding leaks. This process begins with good maps of your distribution system. Maps help cre-

ate an efficient leak detection plan and also help to find lines, valves, and other buried parts of the distribution system where leaks might occur.

MAP SELECTION

Select a map that shows the principle mains of the entire system. Features should include water sources, treatment plants, storage facilities, mains, line sizes, service connections, valves, hydrants, curb stops, elevations, and other utilities. Showing previously repaired leaks and locations of customer complaints may be especially helpful.

MAKING MAPS

Some systems do not have complete or up-to-date maps; this may mean making new ones. You may not, however, need to create a map from a blank sheet of paper. There are several possible sources of help.

Contractors or engineers who installed the original system generally keep a file for each system they design. You might also obtain maps from inspectors, lending agencies, and other people and offices associated with your system's construction. Many state regulatory agencies require that a set of plans and maps be submitted for any original construction or upgrade; these maps should be on file. If you must draw new maps, use aerial photos or regional or county maps to start.

All pipes should be identified according to type, size, and depth. Also, the exact distance from a reference point is useful. Information about valves and hydrants is sometimes kept on separate maps. This information includes the model type, installation date, plus the di-

rection and number of turns for opening valves.

MAPPING FOR THE FUTURE

Even if you do not have maps and choose not to make them now, it is still a good idea to record the location of repairs and new lines on city or county maps. This will provide useful documentation should you decide to map your system in the future.

THE PRELIMINARY SURVEY

Some parts of a water system leak more than others. At the beginning of your leak detection work, perform a preliminary survey. Look for signs of leaks and check the most common places for leaks to occur.

INSPECT THE SYSTEM BY SIGHT

Leaks are found by sight or sound. The simplest way to find leaks is to look for wet spots. A wet spot does not tell you exactly where a leak is, though. Some leaks may flow many feet before surfacing.

Places where you may find leaks by visual inspection. Storage tank overflows, stuck air relief valves, excessive leaks due to old or worn pump packing, new or recently repaired lines, cracked meter bottoms.

DAMAGED FIRE HYDRANTS

Fire hydrants are one of the most common sources of leaks. Valve seats can be damaged or improperly seated. Water can leak past these and out through drain holes inside the hydrant barrel. Some operators check fire hydrants for leaks by listening to each hydrant. Listen for leaks by using one of the listening

devices or techniques described under "Pinpointing Leaks."

If the hydrant is a dry barrel type, you may be able to listen for leaking water without special listening devices. First make sure the hydrant valve is completely closed. Stand to one side of the hydrant (in case it isn't working properly) and remove one of the nozzle caps. If you do not see any signs of a leak, listen from the open nozzle for leaking water.

CUSTOMER COMPLAINTS

Review recent customer contacts. Comments about pressure changes or flow interruption may provide clues about leaks.

THE NEXT STEP

If you still cannot account for a significant part of your water after checking the common sources of leaks, the chances are good that your system has leaks underground. The next step is to proceed with a listening survey to pinpoint the location of the leak.

PINPOINTING LEAKS

Steps in pinpointing leaks include selecting equipment; looking at and listening to all valves, hydrants, pumps, etc., for signs of leaks; and listening to water lines.

LEAK DETECTION EQUIPMENT

Simple devices. The simplest listening device is something that can carry the vibrations caused by a leak. For instance, some operators "listen" to a hydrant by placing the tip of a screwdriver or wrench against the valve stem and the handle next to their ear.

Hydrophone. This is an inexpensive device that works the same way

as a screwdriver or wrench, but is designed for more comfortable and convenient listening.

Geophones. Also inexpensive, these are similar to a doctor's stethoscope.

Electronic leak detectors. These are much more sophisticated and complex than geophones. They amplify sound caused by water vibrations. Operating these devices requires some skill and practice. For assistance, contact ASRWWA or an authorized factory representative.

Leak correlators. This very expensive and complex device is the most elaborate leak detection tool. A microprocessor, it measures the time it takes for sound to travel between two points along a pipe. It is not affected by depths or soil type. Leak correlation services are normally provided by private contractors.

To use a leak correlator successfully, you must know the location and length of the pipe you are checking. This is why you need detailed maps of your system. When accurate data is fed into a leak correlator, the chances of pinpointing leaks are extremely good.

Valve box locators. These are used to help locate valve boxes, curb stops, or manhole covers. Water systems in cold weather states with excessive snow or ice cover may find these especially useful.

Line Tracers. This device is useful when maps are not available to show the location of metal pipe. A line tracer will not locate plastic lines unless a metal wire was installed with the water line.

Useful Tools. Tools that are useful for leak detection include a me-



ASRWWA Water Circuit Rider, Gene Jambor, at one of the Association's recent Technical Conferences. Contact Gene for advice and assistance on leak detection at 860-889-6373 or gene905@aol.com.

ter valve wrench for opening and closing curb stops, a valve wrench for opening and closing main line gate valves, pipe wrenches, a 50' to 100' tape measure, shovels, a pressure gauge, and various fittings.

LISTENING FOR LEAKS

Leak sounds. Leak detection by listening is possible because of two sounds. One is the sound water makes as it leaves a restricted opening. The sound is sent through the pipe wall and along the length of the pipe. The other sound is made by escaping water hitting the surrounding soil.

Leaks can make different sounds. The sound of a leak depends on pipe material, depth of the pipe, composition of the soil, size of the leak, and depth of the water table.

Smaller leaks under high pressure usually make more noise than larger leaks under low pressure. In some cases, large leaks under low pressure make almost no sound. If these do not surface, locating them can be very difficult.

When you hear a leak, try to determine if it is near or far. For example, if you hear water passing through a valve, continue listening from valve to valve throughout the area. Usually, the louder the noise, the closer the leak.

Sounds can be misleading, however. Sometimes the sounds of a leak are confused with traffic noise or wind. Always double-check an area before digging.

Listening to devices. The best place to listen is on the distribution pipe itself. Unfortunately, it is not always easy to get to the pipe. If you can't listen on the pipe, listen on any contact point on the system, including meters, pumps, hydrants, and valves.

Pay special attention to fire hydrants and valves. In the case of a valve, inspect for signs of damage or leaks. Look at the area around the valve for damp spots. Listen to valves for sounds of jetting water when the valve should be closed.

For example, many leaks have been discovered around isolation valves. These are often used for flow shut-off and regulation. Inspect the stem and nut of isolation valves. Inspect the valve for proper operation. Close the valve completely and count the number of turns. Compare this number with other maintenance records if they are available. If the number of turns has changed since the last inspection, the isolation valve may be damaged.

If you hear leak sounds on these devices, the next step is to pinpoint the leak by listening to lines.

Listening to lines: For many water systems, the distribution pipe is non-metallic and the contact points

are far apart. In this case it may be necessary to use a geophone or an electronic ground leak detector to pinpoint underground leaks.

Begin by locating distribution system pipe with a line tracer if the pipes are metallic. Otherwise, use system maps to find the exact location of pipe. You may want to mark the ground that is directly over the buried pipe.

Listen along the line of the pipe every five to ten feet. Mark the spots where the sounds are loudest.

Sounds can be misleading. The vibrations from leaks can travel along the pipe and be heard some distance from the leak. Vibrations may also be caused by other things, such as customer use or leaks on other lines.

Inspect the area above the leak sound again. Look for damp spots or any other thing that may cause a noise. If there is clearly no other reason for water use, and you still hear a noise when you listen again, you have probably discovered a leak.

Note: When you think you have located the leak, review your steps and repeat the listening! If you do not hear the sound again, you have not discovered a leak.

Some leaks occur on customer service lines. Check records for customer complaints of low pressure or water in a basement. For a quick check, close the curb stop. Make sure the customer does not have a tap open. Slowly open the curb stop and listen. If you hear water passing through the valve, the customer may have a leak.

Caution: If you must do some digging, practice good trenching

MAKING ESTIMATES

ESTIMATING VOLUME

Volume in Cubic Feet = 3.14

$\times (\frac{1}{2} \text{ Diameter})^2 \times \text{Height}$.

To convert cubic feet to gallons, multiply by 7.48 ($1 \text{ ft}^3 = 7.48 \text{ gal}$).

EXAMPLE: A storage tank has a diameter of 20 feet and has a height of 40 feet.

$$3.14 \times (\frac{1}{2} \times 20)^2 \times 40 = 12,560 \text{ ft}^3$$

$$12,560 \text{ ft}^3 \times 7.48 = 93,948.8 \text{ gals.}$$

ESTIMATING WATER LOSS

Authorized and unauthorized use.

Bulk use is the easiest unmetered use of water to estimate. This is because water taken from the system enters a truck or tank of known size. If you know the number of times the container was filled, your estimates will be accurate.

For other unmetered connections, compare the unmetered use with a similar metered use. For example, an illegal connection on a stock tank may be very much like another field connection that is metered.

Leaks: If there is no similar metered use to compare to and the leak is in a place that is easy to reach, try to find the amount of time it takes the leak to

safety. Be sure you know where underground utilities are before you start. Beware of buried gas lines, power cables, cable TV, and telephone lines. Before digging, you must contact CALL BEFORE YOU DIG, 1-800-922-4455 in Connecticut, and 1-888-DIG-SAFE in Rhode Island, for assistance with location and marking (call at least two days before you plan to dig).

RECORDING LEAKS

When you repair a leak, measure or estimate the amount of leaking water and record your findings. Include the size of leak, amount of water recovered, cause and type of

fill a bucket of known size. From this figure, you can estimate the amount of water loss in gallons for the record review period.

EXAMPLE: A leak filled a five-gallon bucket in 20 seconds.

$$\frac{5 \text{ gal}}{20 \text{ sec}} = \frac{15 \text{ gal}}{1 \text{ min}} = \frac{900 \text{ gal}}{1 \text{ hr}} = \frac{21,600 \text{ gal}}{1 \text{ day}}$$

If the leak is hard to reach, try calculating the loss. The formula is:

Loss in gallons per minute = 30.394

\times area of hole or crack in square inches
 \times square root of pressure in pounds per square inch.

To find the area of a circle:

Radius = $\frac{1}{2}$ Diameter

Area = $3.14 \times \text{Radius}^2$.

EXAMPLE: A leak is coming from a hole approximately one-quarter inch in diameter. The pressure on the line is 60 lbs/in².

First, find the area of the hole:

$$0.25 \text{ in} = 0.250"$$

$$\text{Radius} = 0.5(0.250") = 0.125"$$

$$\text{Area} = 3.14 \times (0.125)^2 = 0.049 \text{ in}^2$$

Next, put the area into the formula:

$$30.394 \times 0.049 \text{ in}^2 \times 7.75 \text{ psi}$$

$$= 11.54 \text{ gal/min.}$$

leak, location, date located and repaired, and repairs made.

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